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# Application of Expedient Leader-Follower Technology to an Infantry Brigade Combat Team

Bobzin, Lauren; Leichty, Benjamin; Winkler, Austin

Monterey, California. Naval Postgraduate School

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# Application of Expedient Leader-Follower Technology to an Infantry Brigade Combat Team



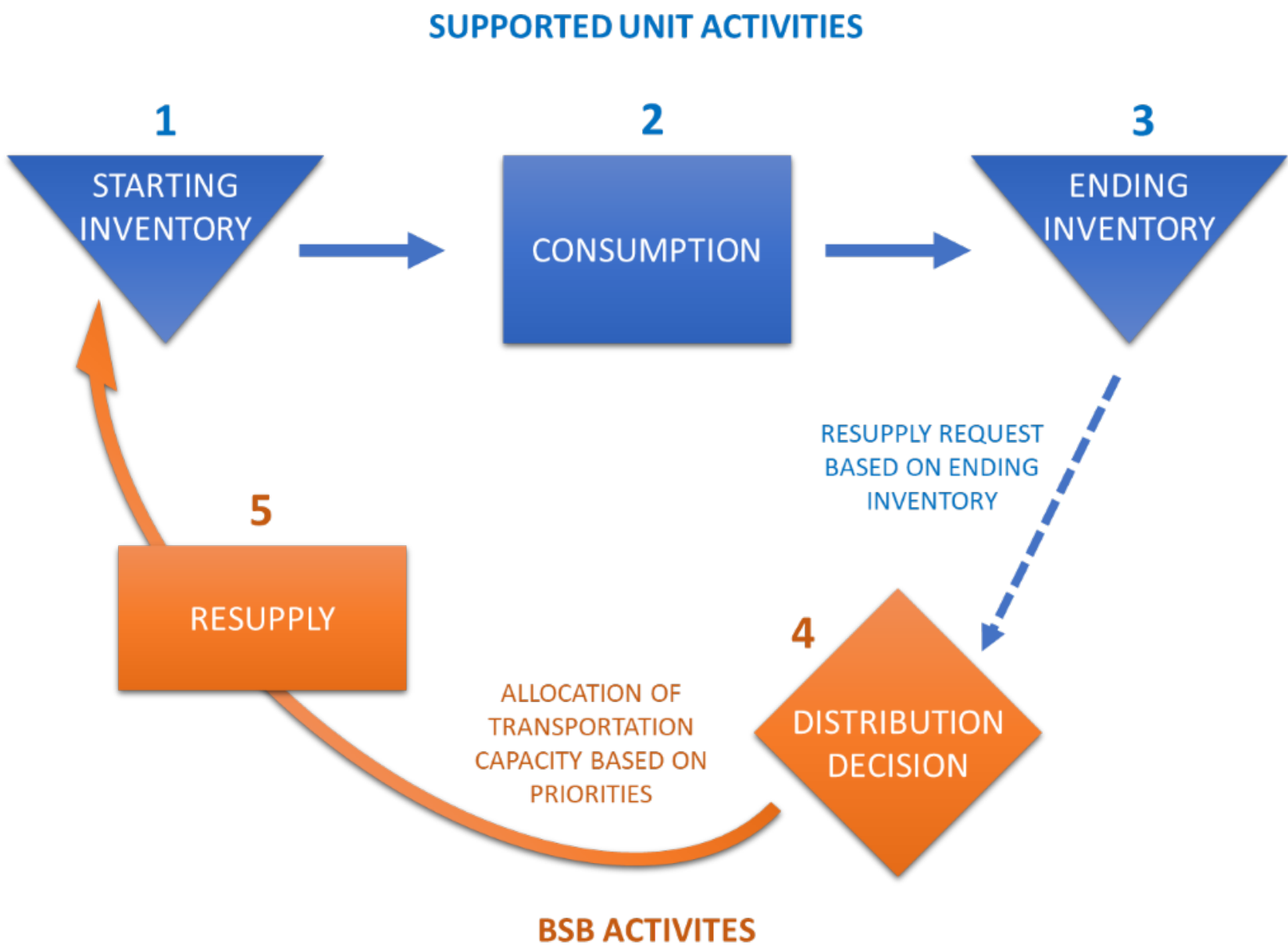
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## Abstract

Autonomous ground resupply (AGR) possesses significant potential to address the growing military transportation gap and alter the future of combat sustainment. An Army Infantry Brigade Combat Team can organically transport only 58% of assigned assets. To address this shortfall, among other capability gaps, the U.S. Army Combat Capability Development Center began researching and testing Expedient Leader Follower (ExLF) AGR technology during Fiscal Year (FY) 2016 and will begin field testing within two Army transportation companies beginning in the fourth quarter of FY2019. ExLF technology provides the capability to conduct a three- to ten-vehicle convoy with one manned vehicle leading the ExLF vehicles in trace. Some key priorities outlined by U.S. Army Combined Arms Support Command include (1) performing convoy operations autonomously and (2) assessing legacy equipment against ExLF equipped convoys. The ExLF technology must provide tangible results across these stated objectives in order to justify the investment across all ground forces, including the Marine Corps.

## Methods

The central aspect of our simulation is the “distribution decision” a supporting logistics unit must make on how best to allocate its limited transportation assets in order to best meet the supply needed of supported units. To address this decision, we formulated an integer programming model to optimize sustainment outcomes based on priority of need and importance to the mission. The key output from our model was *supply risk*, measured by the frequency of supply shortages for each supported unit across three main categories of supply over a 21-day period.



## Results

### Without ExLF

	INFANTRY 1				INFANTRY 2				INFANTRY 3				FIELD ARTILLERY				CAVALRY				ENGINEER			
	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO
1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
2	3.00	2.10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.98	3.00	3.00	3.00	3.00	3.00	3.00	2.02	3.00	3.00	3.00	3.00	2.93	3.00	3.00
3	3.00	3.00	3.00	3.00	3.00	1.91	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.91	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.86	3.00	3.00
4	3.00	2.05	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.07	3.00	3.00	3.00	2.56	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.79	3.00	3.00
5	3.00	3.00	3.00	3.00	3.00	1.95	3.00	3.00	3.00	1.07	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.83	3.00	3.00
6	3.00	2.01	3.00	3.00	3.00	0.85	3.00	3.00	3.00	3.00	3.00	2.96	3.00	1.92	3.00	3.00	3.00	1.89	3.00	3.00	3.00	2.82	3.00	3.00
7	3.00	1.01	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.87	3.00	3.00	3.00	2.54	3.00	2.99	3.00	3.00	3.00	3.00	3.00	1.87	3.00	3.00
8	2.98	3.00	3.00	3.00	2.99	1.97	3.00	3.00	3.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.43	3.00	3.00	3.00	2.79	3.00	3.00
9	3.00	1.84	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.98	3.00	2.08	3.00	3.00	3.00	2.87	3.00	3.00	3.00	3.00	2.75	3.00	3.00
10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.94	3.00	3.00	3.00	2.66	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.67	3.00	3.00
11	3.00	3.00	3.00	3.00	3.00	1.82	3.00	3.00	3.00	1.93	3.00	3.00	3.00	2.62	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.73	3.00	3.00
12	3.00	2.10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.95	3.00	3.00	3.00	2.86	3.00	1.88	3.00	3.00	3.00	2.74	3.00	3.00
13	2.99	3.00	3.00	3.00	3.00	2.06	3.00	2.95	3.00	1.93	3.00	3.00	3.00	2.02	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.71	3.00	3.00
14	3.00	2.10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.58	3.00	3.00	3.00	1.82	3.00	3.00	3.00	3.00	2.73	3.00	3.00
15	3.00	3.00	3.00	3.00	3.00	1.88	3.00	3.00	3.00	1.91	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.66	3.00	3.00
16	3.00	2.01	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.38	3.00	3.00	3.00	3.00	2.68	3.00	3.00
17	3.00	3.00	3.00	3.00	3.00	1.82	3.00	3.00	3.00	1.87	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.64	3.00	3.00
18	3.00	2.05	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.89	3.00	3.00	3.00	2.19	3.00	3.00	3.00	2.61	3.00	3.00
19	3.00	3.00	3.00	3.00	3.00	1.91	3.00	3.00	3.00	2.05	3.00	3.00	3.00	2.35	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.57	3.00	3.00
20	3.00	2.13	3.00	3.00	3.00	0.83	3.00	2.99	3.00	0.96	3.00	3.00	3.00	2.89	3.00	3.00	3.00	1.47	3.00	3.00	3.00	2.52	3.00	3.00
21	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.79	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.52	3.00	3.00
AVG	3.00	2.49	3.00	3.00	3.00	2.33	3.00	3.00	3.00	2.27	3.00	2.99	3.00	2.56	3.00	2.99	3.00	2.51	3.00	3.00	3.00	2.50	3.00	3.00
Days w/DOS < 2 = 37																								

### With ExLF

	INFANTRY 1				INFANTRY 2				INFANTRY 3				FIELD ARTILLERY				CAVALRY				ENGINEER			
	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO	I	III	V	AO
1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
2	3.00	2.10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
3	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
4	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
5	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
6	3.00	2.01	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
7	3.00	3.00	3.00	3.00	3.00	1.99	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
8	3.00	3.00	3.00	3.00	2.99	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
9	3.00	3.00	3.00	3.00	2.99	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
10	3.00	1.97	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
11	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
12	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
13	3.00	3.00	3.00	3.00	3.00	2.06	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
16	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
17	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
18	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	3.00	2.13	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
AVG	3.00	2.82	3.00	3.00	3.00	2.91	3.00	3.00	3.00	2.86	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.93	3.00	3.00	3.00	2.87	3.00	3.00
Days w/DOS < 2 = 4																								

## Analysis

Incorporating ExLF technology demonstrated that increases in transportation capacity would result in improved logistics performance through more timely resupplies. Overall, Class III was the most strained of our categories under the base scenario and also showed the most improvement with the incorporation of ExLF. Therefore, ExLF provided a nearly complete reduction in risk as measured as any occasion where a supply category falls below 2 DOS.